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Book Review

Theory of Planetary Atmospheres. J. W. Chamberlain. Academic Press, New York, 1978. 330 pp., $29.50.

This is a most welcome book. Despite the great interest in planetary atmospheres generated by spacecraft exploration and despite the key role that an understanding of atmospheres must play in crucial problems such as climate prediction and assessment of man's impact on the environment, there is a dearth of good books on the physics and chemistry of planetary atmospheres. I suspect that this is due to the broad range of disciplines involved in the studies of planetary atmospheres, and the impossibility of one person performing research in all of the important areas. The material in Chamberlain's book largely reflects his own research interests, which accounts for some of the main weaknesses and omissions of the book. However, the substantial extent to which Chamberlain has succeeded in producing a valuable teaching and reference book is in fact a tribute to the breadth of his many research accomplishments.

The book treats the radiation, chemistry, and dynamics of planetary atmospheres. The seven chapters concern (1) atmospheric structure, (2) atmospheric dynamics, (3) chemistry and dynamics of the Earth's stratosphere, (4) remote sensing of planetary atmospheres, (5) ionospheres, (6) airglow and aeronomy, and (7) a chapter which starts out as though it will be on climate and atmospheric evolution, but essentially treats only atmospheric escape.

The treatment of atmospheric radiation is sound, beginning with basic definitions and proceeding through simple cases which can be solved analytically or semianalytically. Thus two-stream and single scattering solutions are obtained and there is a discussion of multiple scattering as a random walk process by photons. Remote sensing is considered in detail for absorption line formation in an isotropically scattering atmosphere and there is a discussion of the polarization analysis of Venus' cloud properties.

My main criticism of the radiation portion, also partially applicable to the chemistry and dynamics, is the absence of a clear indication of how analysis proceeds when our knowledge has progressed to the point where simple models and analytic solutions are inadequate. One is left with the impression that the procedure for more in-depth analysis of planetary atmospheres requires only use of "sufficiently large computers." In fact, although computers are a useful tool, they often do more harm than good; progress is impeded by hasty publication of numerical results which leave us with a swollen literature and conclusions which are difficult to check and often undeserving of our confidence. Thus I wish that Chamberlain had taken the opportunity to choose one or two research problems as examples to illustrate the scientific rationale behind remote sensing of planetary atmospheres: definition of the problem, determination of the physical content of the observations and its relation to key parameters in the theory, and specification of appropriate procedures to extract the key and secondary parameters.

The chapter on atmospheric dynamics, about 30 pages in length, is too brief for a thorough treatment and is thus not expected to satisfy those readers specializing in dynamics. However, it does contain basic definitions of value to the nonspecialist and useful discussion of the atmospheric dynamics of Earth, Venus, Mars, and Jupiter. The discussion revolves mainly around time constants and to a lesser extent around dynamical parameters such as the Rossby, Rayleigh, and Taylor numbers. This approach is at least partially successful in leaving the impression that such a remarkable array of very different planets is described by specific domains of a single theory. Readers should not expect to come away with a deep understanding of atmospheric dynamics, for the true utilization of the family of planets for this purpose remains a challenge to the experts in the field.

The treatment of atmospheric chemistry covers ozone photochemistry in great detail, including the roles of the now famous HO_x, NO_x, and ClO_x families. This is a welcome addition to texts on planetary atmospheres in view of the practical importance the subject has attained. Chamberlain's treatment is excellent and should be of value to both professionals not specializing in atmospheric chemistry and students in chemistry. It can be anticipated that details of the approximately 100 reactions considered will soon become dated. Unfortunately there does not seem to be available a simplified treatment of the subject which allows one to identify the key processes and reactions, including verification that all the essential ingredients have been included. As a result one is left with the nagging suspicion that the predictions of the present models for the impact of fluorocarbons, fertilizers, exhaust products, etc., on atmospheric composition may prove to be far off the mark. The range of chemistries on the planets surely must provide excellent opportunities for testing our general understanding of atmospheric chemistry. I am disappointed that there was not a more serious attempt in this book to consider atmospheric chemistry in the broad context of the planets. There is, however, a useful section on aeronomy of the planets at the end of Chapter 6 and a bibliography of the major papers in this area.

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Chapter 5 on ionospheres, Chapter 6 on airglow and aeronomy, and Chapter 7, basically on atmospheric escape, all seem to be excellent as far as I am able to judge. The final section of Chapter 7, on atmospheric evolution and climate, is so brief and oversimplified that it would perhaps have been better to omit it altogether. Apparently the main purpose of the section is to allow the author to discuss his suggestion that fluctuations in the Earth's magnetic field may lead successively to: increased cosmic rays in the stratosphere, NO_x production, O_3 destruction, climate change, and faunal extinction. Most of the other 5000 or so theories of climate change are not mentioned. The explanation offered, "We can only touch on climate theory qualitatively here because even elementary quantitative projections necessarily involve the creation of elaborate computer models," reemphasizes the author's misconception about modern research techniques and the role of computers.

In summary, if judged on the basis of what I would ideally like to see in such a book, it has serious flaws such as the failure to take full advantage of the opportunity to study terrestrial atmospheric processes in the planetary context, a weak treatment of climate and atmospheric evolution and the absence of any cloud physics. However, I also believe that it is a very excellent and careful work of value for both teaching and research. A good set of problems and an extensive up to date bibliography is contained at the end of each chapter. *I believe that it is the best available book on its subject area and I strongly recommend it to all students and researchers in planetary atmospheres.*

For the convenience of potential users of the book, the following are typographic errors communicated by the author:

Page 64, last term in (2.3.4) should be

$$\frac{\Phi_1 H}{K} \qquad \text{[H is omitted]}$$

Page 157, fourth line from bottom, "(4.58)" should read "(4.2.6)"

Page 162, Prob. 4.7, the r.h.s. of the equation should read

$$\frac{2nS\mathcal{N}}{\Gamma_0} \ln [. \ . \ .] \qquad [\mathcal{N} \text{ is omitted}]$$

Page 173, (5.1.32)

$$y_j = N_j e^{(z-z_0)/4H_j} \qquad \text{[4 is omitted]}$$

Page 189, (5.2.43)

$$\omega_0^2(z_0) \qquad [\text{subzero on } z_0 \text{ is omitted}]$$

Page 304, footnote to Table III.2

$$\xi = 8.0 \times 10^5 \qquad [\text{not } 8.9 \times 10^5]$$

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